ORIGINAL ARTICLE

Factors associated with nosocomial pneumonia in hospitalized individuals

Thaís Feitosa Leitão de Oliveira[1], Isaac Suzart Gomes Filho[2], Johelle de Santana Passos[3], Simone Seixas da Cruz[4], Michelle Teixeira Oliveira[1], Soraya Castro Trindade[5], Adelmir de Souza Machado[6], Julita Maria Freitas Coelho[7], Carla Maria Lima Santos[8], Eneida de Moraes Marcílio Cerqueira[9]

[1] MSc in Organ and System Interactive Processes; Researchers of NUPPIIM – Universidade Estadual de Feira de Santana (UEFS), Feira de Santana, BA, Brazil
[2] PhD in Periodontics; Full Professor, UEFS, Feira de Santana, BA, Brazil
[3] MSc in Collective Health; Visiting Professor, UEFS, Feira de Santana, BA, Brazil
[4] PhD in Epidemiology; Adjunct Professor, Universidade Federal do Vale do São Francisco, Petrolina, PE, Brazil
[5] PhD in Immunology; Adjunct Professor, UEFS, Feira de Santana, BA, Brazil
[6] PhD in Medicine; Adjunct Professor, Instituto de Ciências da Saúde, Universidade Federal da Bahia (UFBA), Salvador, BA, Brazil
[7] PhD in Epidemiology; Adjunct Professor, UEFS, Feira de Santana, BA, Brazil
[8] MSc in Collective Health; Substitute Professor, UEFS, Feira de Santana, BA, Brazil
[9] Post-doctorate Degree in Genetics; Professor of the Postgraduate Program in Collective Health, UEFS, Feira de Santana, BA, Brazil

Summary

Objective: To identify factors associated with nosocomial pneumonia in individuals admitted to a public hospital in Feira de Santana, Bahia. **Methods:** This case-control study was carried out in 211 adult individuals (46 cases and 165 controls), of a mean age of 41 years, treated at clinical wards, surgical wards or the adult intensive care unit of Clériston Andrade General Hospital in Feira de Santana. The cases comprised individuals who developed respiratory tract infections (nosocomial pneumonia) after hospital admission. The controls consisted of patients without nosocomial pneumonia. Information on socioeconomic status, medical history, lifestyle and oral hygiene habits was obtained through interviews. The medical records were checked to verify subjects' health status and the diagnosis of pneumonia. A clinical oral examination was performed by a trained dental surgeon. Odds ratio (OR) was estimated in the bivariate analysis as an association measurement, along with the respective 95% confidence interval through the Mantel-Haenszel method. **Results:** The frequency of nosocomial pneumonia in the sample was 21.8%. The occurrence of hypertension was higher and hospital stay duration was longer in the cases than in controls ($p \leq 0.05$). Lack of dental floss and mouthwash use were higher in the controls ($p = 0.01$). **Conclusion:** The findings indicate that arterial hypertension, lenght of hospital stay of five days and lack of dental floss and mouthwash use are factors likely associated with nosocomial pneumonia, suggesting that these factors should be targeted for effective prevention.

Keywords: Pneumonia; epidemiology; odds ratio; risk factors.

Study conducted at Universidade Estadual de Feira de Santana (UEFS), Feira de Santana, BA, Brazil

Submitted on: 02/18/2011
Approved on: 09/06/2011

Financial Support:
Fundação de Amparo à Pesquisa do Estado da Bahia (FAPESB)

Correspondence to:
Isaac Suzart Gomes Filho
Núcleo de Pesquisa, Prática Integrada e Investigação Multidisciplinar - NUPPIIM/UEFS
Km 03, BR 116
Campus Universitário – 6º módulo
CEP: 44031-460
Feira de Santana, BA, Brazil
isuzart@gmail.com

Conflict of interest: None.

Introduction

Nosocomial pneumonia (NP) develops in the hospital environment and is not present, or incubated in the patient at the time of the hospital admission. It has been recognized as an important public health problem in Brazil and the world, as it is a major cause of morbidity and mortality in hospitalized individuals. NP also poses a high financial burden for society, since it increases therapeutic demand and hospital stay duration. In Brazil, hospital-acquired respiratory infections account for 13 to 18% of all infections acquired in this environment[1]. However, there are scarce data systematizing the actual prevalence of NP in Brazilian hospitals[2].

Some factors seem to be associated with the NP, establishing vulnerable groups: patients submitted to orotracheal intubation and/or mechanical ventilation; patients with lower level of consciousness; individual victims of aspiration of large volume of secretions; poor oral status; patients with chronic obstructive pulmonary disease; the elderly; previous use of antimicrobial agents; presence of a gastric tube; severe trauma; and recent bronchoscopy[3,4].

This respiratory infection can occur by microaspiration of colonized oropharyngeal secretions, aspiration of gastroesophageal content, inhalation of infected aerosols. Less frequently it can occur by hematogenous dissemination from a distant site of infection, exogenous penetration, direct inoculation into the airway in patients intubated by the staff at the intensive care unit (ICU), and massive aspiration of gastric contents. The translocation of bacteria from the gastrointestinal tract has also been recently considered as a mechanism of pulmonary infection[5,6].

After the identification of dental biofilm bacteria in the oropharyngeal cavity in the 70s, it has been suggested that NP may be associated with bacterial composition of dental biofilm, and this colonization may be favored or aggravated as a result of neglected oral hygiene during patients' hospitalization[7,8].

Considering the relevance of this subject and the impact of this respiratory tract infection on morbimortality in Brazil, the objective of this study was to identify the main factors associated with nosocomial pneumonia in patients admitted to a public hospital, in Feira de Santana – BA.

Methods

This is a case-control study carried out in subjects admitted to Hospital Geral Cleriston Andrade (HGCA) in Feira de Santana, state of Bahia, Brazil, from May to September 2010. The case group consisted of patients with a diagnosis of NP and the control group of patients without NP. Only incident cases of NP were evaluated in the period established for data collection.

The minimum sample size was determined for a larger project entitled "Association between periodontal disease and nosocomial pneumonia" that gave origin to this study. The initial estimate of sample size calculation used a power of study of 90%, confidence interval of 95%, based on the literature journal that used employed a range varying from 1.5 to 4.0 more chances of an individual to develop nosocomial respiratory tract infection in the presence of periodontal disease. In this study, 46 cases and 165 controls were selected[9,10].

The case and control groups consisted only of patients who were being treated at the Intensive Care Unit, Medical or Surgical Clinic of the same hospital - Hospital Geral Cleriston Andrade, in an attempt to increase the similarity between the groups. These individuals were selected according to the medical criteria of semiology and diagnosis of respiratory infection. The specialized medical staff of the hospital was responsible for the diagnosis in the medical record of each participant in the study.

The eligibility criteria for the cases were: individuals aged 18 years and older with respiratory tract infection acquired after hospital admission, regardless of the cause of admission (except for lung involvement) diagnosed by the medical staff of the HGCA.

Control selection was gradually carried out as cases were included, and individuals had to be admitted at the same hospital, and during the same period of case identification. They had to be from one of the three clinical units aforementioned. They could not present any clinical or radiographic sign of NP, which guaranteed the non-case status.

Exclusion criteria for both groups were: individuals younger than 18 years old, admitted at the hospital with a diagnosis of community-acquired pneumonia, or treated in other wards that of the HGCA rather than the ICU, Medical and Surgical Clinics.

As some studies indicate that poor oral health status is a possible risk factor for NP, dental examinations were carried out at the bedside to assess signs of gingival inflammation and level of dental care by a trained dentist, blinded to presence of NP in the assessed individual. Thus, we also excluded individuals who had clinical signs and symptoms of *delirium tremens*, fever and marked angular cheilitis or needed equipment such as the nasogastric tube, which prevented the performance of oral examination.

The diagnosis of NP was established by assistant physicians of HGCA. They had considered the presence of recently identified infiltrations on chest X-rays combined with at least one of the following criteria: fever, leukocytosis or leukopenia, coughing and purulent sputum or bacterial growth in tracheal secretion or catheter tip culture, present after at least 48 hours of hospitalization[1]. It must be pointed out that there was no pairing for any confounding factors in this sample selection process.

Questionnaires, medical records and oral clinical assessment were used as data collection instruments to

investigate possible risk factors (advanced age, poor oral health status, lenght of hospital stay, presence of gastric tube, mechanical ventilation, alcoholism, presence of chronic diseases and severe trauma).

Data were obtained through interviews performed with hospitalized individuals or their tutors/caregivers, when patients could not answer by themselves. For that purpose, a semi-structured questionnaire was applied, which explored the following themes: sociodemographic characteristics, lifestyle, general health and dental health status. The questionnaires were applied by researchers that had been previously trained to perform them, so as to minimize information biases, which could compromise the internal validity of the study. Upon arrival at the hospital, a researcher with a background in nursing carried out the identification of cases and controls, indicating them to the interviewer who applied the questionnaire. At the moment of the interview, the previously trained interviewer was blinded to the diagnostic status of the subjects regarding NP, having access to medical records only after completion of the initial questionnaire application.

Additionally, with the objective of minimizing research biases, participants whose tutors or caregivers were not able to answer questions due to the fact that they did not know their routine were not included in the sample. After the questionnaire was applied, a dentist performed the dental clinical examination with the help of an assistant.

The variables analyzed in this study were: age (18-41 years and > 41 years), sex, self-reported ethnicity/skin color (non-Caucasian or Caucasian), level of schooling (≤ 4 years or > 4 years of schooling), family income (≤ 1 or > 1 minimum wage [MW]), socioeconomic class (A/B/C or D/E) according to the criterion of the Brazilian Association of Research (ABEP), marital status (with partner or without partner), practice of physical activity (yes or no), smoking (nonsmoker or ex-smoker/smoker), alcohol consumption (yes or no), diabetes (yes or no), hypertension (yes or no), allergies (yes or no), heart disease (yes or no), asthma (yes or no), bone diseases (yes or no), illicit drug use (yes or no), hospital stay duration (≥ 5 days or < 5 days), reason for hospitalization (external causes/trauma or infectious disease/chronic-degenerative diseases/cancer), type of ventilation (invasive or non-invasive), dental floss use (yes or no), use of mouthwash (yes or no), regular visits to the dentist (yes or no), professional recommendations on oral hygiene (yes or no), number of teeth (> 20 or 6-20 teeth), and gingival bleeding (< 25% or ≥ 25%). The categorization of continuous variables, when required, was made based on their distribution or according to cutoffs identified in the literature.

To compare the frequency of nosocomial pneumonia according to the study variables, the Chi-square (χ^2) Pearson's and Fisher's exact tests were used, with an alpha value of 5%. Subsequently, a bivariate analysis was performed between the socioeconomic and biological factors and nosocomial pneumonia, estimating the odds ratio (OR) as a measure of association and their respective 95% confidence intervals (95% CI) using the Mantel-Haenszel method. STATA software release 9.0 was used for data processing and analysis.

All participants signed the free and informed consent form. This study was approved by the Ethics Committee of the Universidade Estadual de Feira de Santana, Bahia, Brazil (protocol # 079/2007).

Results

The sample consisted of 211 adult individuals with a mean age of 41 ± 17.01 years, of which 85.8% were males. Only two individuals in the control group refused to participate and one individual was excluded from the sample, as the tutor/caregiver stated being unaware of the routine patient care. The frequency of nosocomial pneumonia in the sample was 21.8%, consisting of 46 cases and 165 controls. As for the demographic data displayed in Table 1, there were some differences between cases and controls; however, they were not statistically significant ($p > 0.05$).

Regarding the comorbidities shown in Table 2, only hypertension was statistically associated with nosocomial pneumonia, being twice more frequent in the group of cases than in controls (OR: 2.22, 95% CI: 1.05-4.72, $p = 0.02$). As for the hospital stay duration ≥ 5 days (interval between date of admission and date of collection), this showed to be approximately 10 times higher in cases of pneumonia than in controls and this difference was statistically significant (95% CI: 2.73-41.01, $p < 0.001$).

As for the characteristics related to oral hygiene habits and oral health status of hospitalized individuals, Table 3 shows that lack of dental floss use (OR: 0.43, 95% CI: 0.21-0.90), as well as lack of mouthwash use (OR: 0.38, 95% CI: 0.17-0.85) were statistically associated with pneumonia cases. Although the number of teeth did not show a statistically significant difference between groups, we observed a higher frequency of cases among individuals with fewer teeth (6 to 20 teeth). The same can be said regarding gingival bleeding, of which chance of occurrence was almost two-fold higher in patients with pneumonia (OR = 1.94, 95% CI: 0.65-5.59) than in the control group.

Discussion

The present study showed a high frequency of nosocomial pneumonia among the study individuals (approximately 22%), reinforcing the fact that identifying these infections is a major public health problem in Brazil, as well as the main iatrogenic cause of hospitalized individuals submitted to curative interventions.

It is noteworthy the fact that even though this hospital infection represents an imbalance between normal microbial flora and defense mechanisms, commonly observed in

Table 1 – Distribution of cases and controls, odds ratio (OR), confidence interval (95% CI) according to sociodemographic characteristics and lifestyle in Feira de Santana – BA, 2010

Variable	Total n (%)	Controls (n = 165) n (%)	Cases (n = 46) n (%)	OR	95% CI	p
Age						
18-41 years	117 (55.5%)	92 (55.8%)	25 (54.3%)	1.00		
> 41 years	94 (44.5%)	73 (44.2%)	21 (45.7%)	1.06	0.52-2.14	0.86
Sex						
Female	30 (14.4%)	23 (13.9%)	7 (15.2%)	1.00		
Male	181 (85.8%)	142 (86.1%)	39 (84.8%)	0.90	0.34-2.51	0.83
Ethnicity*						
Caucasian	27 (13.0%)	21 (12.8%)	6 (14.0%)	1.00		
Non-Caucasian	180 (87.0%)	143 (87.2%)	37 (86.0%)	0.91	0.32-2.71	0.84
Marital status						
With partner	188 (89.5%)	150 (90.9%)	38 (84.4%)	1.00		
Without partner	22 (10.5%)	15 (9.1%)	7 (15.6%)	1.84	0.63-5.26	0.21
Years of schooling						
> 4 years	131 (63.0%)	100 (61.3%)	31 (68.9%)	1.00		
≤ 4 years	77 (37.0%)	63 (38.7%)	14 (31.1%)	0.72	0.33-1.53	0.35
Socioeconomic class						
A/B	32 (15.2%)	23 (13.9%)	9 (19.6%)	1.00		
C/D/E	179 (84.8%)	142 (86.1%)	37 (80.4%)	0.67	0.27-1.70	0.35
Family income (in minimum wages)						
> 01 MW	139 (65.9%)	107 (64.8%)	32 (69.6%)	1.00		
Up to 01 MW	72 (34.1%)	38 (35.2%)	14 (30.4%)	0.81	0.38-1.72	0.55
Smoking habit						
Non-smoker	113 (53.6%)	87 (52.7%)	26 (56.5%)	1.00		
Smoker/ex-smoker	98 (46.4%)	78 (47.3%)	20 (43.5%)	0.86	0.42-1.74	0.65
Alcohol consumption						
No	107 (50.7%)	81 (49.1%)	26 (56.5%)	1.00		
Yes	104 (49.3%)	84 (50.9%)	20 (43.5%)	0.74	0.36-1.50	0.37
Physical activity practice						
Yes	45 (21.4%)	33 (20.1%)	12 (26.1%)	1.00		
No	165 (78.6%)	131 (79.9%)	34 (73.9%)	0.71	0.31-1.64	0.38

* Three missing data.

critically ill patients, this imbalance may be due to certain health conditions responsible for hospitalization, or invasive and immunosuppressive procedures to which patients are submitted[11].

With regard to the comorbidities presented by the individuals, hypertension was associated with nosocomial pneumonia cases, probably because it is associated with other chronic illnesses that may have weakened the individual, thus favoring the respiratory infection.

Concerning the possible risk factors studied, lenght of stay ≥ 5 days is noteworthy, which suggests that the longer the hospitalization period, the greater the likelihood of a patient developing hospital-acquired respiratory infections. This fact corroborates the work of Lisbon et al.[2] and Amaral et al.[12]. Studies have shown that prolonged hospital stay is closely related with salivary flow. It is known that salivary secretion has a significant role in maintaining oral health. When it is suppressed or diminished, it causes

Table 2 – Distribution of cases and controls, odds ratio (OR), confidence interval (95% CI) according to the health status in Feira de Santana – BA, 2010

Variable	Total n (%)	Controls (n = 165) n (%)	Cases (n = 46) n (%)	OR	95% CI	p
Hypertension						
No	156 (73.9%)	128 (77.6%)	28 (60.9%)	1.00		
Yes	55 (26.1%)	37 (22.4%)	18 (39.1%)	2.22	1.05-4.72	0.02
Diabetes						
No	185 (87.7%)	144 (87.3%)	41 (89.1%)	1.00		
Yes	26(12.3%)	21(12.7%)	5 (10.9%)	0.84	0.26-2.54	0.73
Allergies						
No	202 (95.7%)	158 (95.8%)	44 (95.7%)	1.00		
Yes	9 (4.3%)	7 (4.2%)	2 (4.3%)	1.03	0.10-5.65	0.62
Heart disease						
No	191 (90.5%)	151 (91.5%)	40 (87.0%)	1.00		
Yes	20 (9.5%)	14 (8.5%)	6 (13.0%)	1.62	0.48-4.83	0.35
Asthma						
No	208 (99.0%)	162 (98.8%)	46 (100.0%)	1.00		
Yes	2 (1.0%)	2 (1.2%)	0	0	–	0.61
Bone disease						
No	207 (98.1%)	162 (98.2%)	45 (97.8%)	1.00		
Yes	4 (1.9%)	3 (1.8%)	1 (2.2%)	1.2	0.02-15.35	0.63
Use of medications						
No	179(85.6%)	136 (83.4%)	43 (93.5%)	1.00		
Yes	30 (14.4%)	27 (16.6%)	3 (6.5%)	0.35	0.07-1.23	0.06
Time of hospitalization						
< 5 days	68 (32.9%)	65 (40.4%)	3 (6.5%)	1.00		
≥ 5 days	139 (67.1%)	96 (59.6%)	43 (93.5%)	9.7	2.73-41.01	<0.001
Reason for hospitalization						
External causes/trauma	95 (45.2%)	75 (45.7%)	20 (43.5%)	1.00		
Infectious/chronic-degenerative diseases/ neoplasias	115 (54.8%)	89 (54.3%)	26 (56.5%)	1.1	0.54-2.23	0.79
Type of ventilation						
Noninvasive	19 (36.5%)	5 (62.5%)	14 (31.8%)	1.00		
Invasive	33 (63.5%)	3 (37.5%)	30 (68.2%)	3.57	0.61-22.60	0.12

dry mouth, difficulty in swallowing the food bolus and increased risk of developing opportunistic infections.

Amerongem et al.[13] reported that the presence of specific immunoglobulins and antimicrobial enzymes in the saliva such as lactoferrin, lysozyme and lactoperoxidase is of crucial importance for body defense and health maintenance. Patient sedation in intensive care units and lenght of hospital stay cause low salivary secretion and promote changes in the oral microbial flora in a few weeks, favoring the prevalence of Gram-negative bacteria, thus allowing infections due to aspiration of these pathogens[14,15].

In the study by Oliveira et al.[16], of the 151 patients who had a hospital stay duration > 4 days, 114 (77%) developed nosocomial infection (RR 10.2, 95% CI: 8.5-12.3). In the same study, the frequency of patients with nosocomial infection that used mechanical ventilation was 49.6%, a condition also observed more frequently in ventilated subjects in this study. These data reinforce the role of mechanical

Table 3 – Distribution of cases and controls, odds ratio (OR), confidence interval (95% CI) according to oral hygiene care and oral health status in Feira de Santana – BA, 2010

Variable	Total n (%)	Controls (n = 165) n (%)	Cases (n = 46) n (%)	OR	95% CI	p
Use of dental floss						
Yes	65 (30.8%)	44(26.7%)	21 (45.7%)	1.00		
No	146 (69.2%)	121 (73.3%)	25 (54.3%)	0.43	0.21-0.90	0.01
Use of mouthwash						
Yes	44 (20.9%)	28 (17.0%)	16 (34.8%)	1.00		
No	167 (79.1%)	137 (83.0%)	30 (65.2%)	0.38	0.17-0.85	0.01
Regular visits to the dentist						
Yes	39 (18.6%)	29 (17.6%)	10 (22.2%)	1.00		
No	171 (81.4%)	136 (82.4%)	35 (77.8%)	0.75	0.31-1.82	0.62
Professional recommendations on oral hygiene						
Yes	64 (30.8%)	51 (30.9%)	13 (30.2%)	1.00		
No	144 (69.2%)	114 (69.1%)	30 (69.8%)	1.03	047-2.29	0.93
N. of teeth present						
> 20	104 (49.3%)	84 (50.9%)	20 (43.5%)	1.00		
06- 20	107 (50.7%)	81 (49.1%)	26 (56.5%)	1.35	0.66-2.74	0.37
Gingival bleeding						
< 25%	190 (90.0%)	151 (91.5%)	39 (84.8%)	1.00		
≥ 25%	21 (10.0%)	14 (8.5 %)	7 (15.2%)	1.94	0.65-5.59	0.18

ventilation as a probably significant risk factor in the etiology of this disease, as these ventilation systems are often contaminated by bacteria from the patients themselves, serving as a main route of entry into the lower respiratory tract.

Also regarding oral hygiene, there was statistically significant association between lack of use of dental floss and mouthwash. However, we stress the fact that there was a higher reported frequency of dental floss and mouthwash use in cases than in controls. It is likely that this higher frequency of use was reported by those who have or had a history of periodontal problems, and tried to incorporate into their routine the use of these methods of oral disease control.

In the study of oral health factors associated with respiratory infection, it is noteworthy that the presence of existing teeth and the degree of periodontal involvement are important components in this issue. It is known that the oral flora of individuals with teeth is quite different from edentulous ones. If, on the one hand, there is a lower prevalence of aerobic bacteria in the absence of teeth, there is a concentration of lactobacilli and fungi[17], particularly in poorly cleaned dentures worn by frail elderly who cannot keep their dentures clean enough, and end up being a reservoir of respiratory pathogens, which, when swallowed or inhaled, can cause unexpected infections[18,19].

In our study, the frequency of subjects with fewer than 20 teeth (minimum number of functional teeth estimated by the World Health Organization to achieve the goal for the year 2010[20]) was higher in cases of nosocomial pneumonia, as well as the magnitude of the association between gingival bleeding and pneumonia was almost two-fold higher, although not proven statistically significant.

In spite of the care regarding the study methodology in order to guarantee the reliability of the independent variable (nosocomial pneumonia) and the care to prevent false positives as much as possible, such as standardization of diagnostic criteria of the disease, and training of examiners and interviewers, some limitations are imposed by this study with emphasis on the retrospective nature of the analytical design, possible memory biases, as some questions required self-reported information and the reduced statistical power resulting from insufficient sample to detect associations between risk factors and nosocomial pneumonia.

Furthermore, we stress the non-adequate control of confounding factors such as age, as the older the age group, the greater the likelihood of hospital infections. Another limitation refers to the selection criteria for controls that involved hospitalized patients who often had multiple comorbidities and the results may differ from those of the general population, preventing the generalization of findings (Berkson's bias).

Therefore, we suggest further studies with appropriate sample sizes for identification of possible factors associated with nosocomial pneumonia and thus achieve control and reduction of this infection, as well as confirmatory studies to better investigate the associations found herein, as in the case of arterial hypertension and oral hygiene care.

Conclusion

Therefore, we can conclude that, although the bacterium is a necessary factor for respiratory disease, it is not sufficient to cause infection alone. Other factors are involved and should be considered, such as the ones which affect the neurological control of deglutition and breathing and thus favor the aspiration of oropharyngeal contents or oral bacteria, the existence of associated comorbidities and oral hygiene habits.

Thus, professional awareness should be emphasized aiming at professional excellence, as well as the holistic approach of the hospitalized individual to minimize the occurrence of nosocomial pneumonias.

Acknowledgements

To Fundação de Amparo à Pesquisa do Estado da Bahia (FAPESB) and Universidade Estadual de Feira de Santana for their financial support of this research.

References

1. Medeiros EAS. Treatment of nosocomial pneumonia: a prospective and multicenter study used cefepime. Rev Assoc Med Bras. 1999;45:2-8.
2. Lisboa T, Faria M, Hoher JÁ, Borges LAA, Gómez J, Schifelbain L, et al. Prevalência de infecção nosocomial em unidades de terapia intensiva do Rio Grande do Sul. Rev Bras Terap Intensiva. 2007;19:414-420.
3. Cardoso AP, Menezes AMB, Lemos ACM, Farias AMC, Torres B, Franco CAB, et al. Consenso brasileiro de pneumonias em indivíduos adultos imunocompetentes. J Pneumol. 2001;27 (Supl 1):S1-S32.
4. Marik PE. Aspiration syndromes: aspiration pneumonia and pneumonitis. Hosp Pract (Minneap). 2010;38:35-42.
5. Chawla R. Epidemiology, etiology, and diagnosis of hospital-acquired pneumonia and ventilator-associated pneumonia in Asian countries. Am J Infect Control. 2008;36:93-100.
6. Paju S, Scannapieco FA. Oral biofilms, periodontitis, and pulmonary infections. Oral Dis. 2007;13:508-12.
7. Koeman M, van der Ven AJ, Hak E, Joore HC, Kaasjager K, de Smet AG, et al. Oral decontamination with chlorhexidine reduces the incidence of nosocomial pneumonia. Am J Respir Crit Care Med. 2006 15;173:1348-55.
8. Pace CC, McCullough GH. The association between oral microorgansims and aspiration pneumonia in the institutionalized elderly: review and recommendations. Dysphagia. 2010;25:307-22.
9. Dupont WD, Plummer WD. Power and sample size calculations: a review and computer program. Control Clin Trials. 1990;11:116-28.
10. Dupont WD. Power calculations for matched case-control studies. Biometrics. 1988;44:1157-68.
11. Fernandes AT, Ribeiro-Filho N, Barroso EA. Conceito - cadeia epidemiológica das infecções hospitalares e avaliação custo-benefício das medidas de controle. In: Fernandes AT, editores. Infecção hospitalar e suas interfaces na área da saúde. São Paulo: Atheneu; 2000. p.215-65.
12. Amaral SM, Cortês AQ, Pires FR. Nosocomial pneumonia: importance of the oral environment. J Bras Pneumol. 2009, 35:1116-1124.
13. Amerongen AVN, Veerman ECI. Saliva: the defender of the oral cavity. Oral Dis. 2002;8:12-22.
14. Fourrier F, Duvivier B, Boutigny H, Roussel-Delvallez M, Chopin C. Colonization of dental plaque: a source of nosocomial infections in intensive care unit patients. Crit Care Med. 1998;26:301-8.
15. Russell SL, Boylan RJ, Kaslick R, Scannapieco FA, Katz RV. Respiratory pathogen colonization of the dental plaque of institutionalized elders. Spec Care Dentist. 1999,19:128-34.
16. Oliveira AC, Kovner CT, Silva RS. Infecção hospitalar em unidade de tratamento intensivo de um hospital universitário brasileiro Rev Latinoam Enferm. 2010;18:97-104.
17. Terpenning M. Geriatric oral health and pneumonia risk. Clin Infect Dis. 2005;40:1807-10.
18. Sumi Y, Miura H, Michiwaki Y, Nagaosa S, Nagaya M. Colonization of denture plaque by respiratory pathogens in dependent elderly. Arch Gerontol Geriatr. 2007;44:119-24.
19. Theilade E, Budtz-Jorgensen K, Theiladc J. Predominant cultivable microtiora of plaque on removable dentures in patients with healthy oral mucosa. Arch Oral Biol. 1983;28:675-4.
20. Hobdell MH, Myburgh NG, Kelman M, Hausen H. Setting global goals for oral health for the year 2010.Int Dent J. 2000;50:245-9.